

considerable depths in the higher elevations of California, Idaho, and eastern Oregon, but in other districts no considerable amounts had been stored.

RELATIVE HUMIDITY.

The moisture in the atmosphere as disclosed by the average relative humidity shows rather discordant conditions when the indications from near-by stations are

compared. No extensive areas had uniformly positive or negative departures from the normal, and large and small departures are frequently shown for stations in close proximity.

In general, the average relative humidity was considerably above normal from the middle Mississippi Valley westward and below to about the same extent in the Gulf States, Appalachian Mountain districts, and in the far Northwest.

STORMS AND WARNINGS—WEATHER AND CROPS.

STORMS AND WEATHER WARNINGS.

Washington Forecast District.—The month was marked by unusual activity in the development and movement of lows across the country and by the absence of Alberta highs until near the end of the month. As a consequence storm warnings were required more than the usual number of times and no cold-wave warnings were issued until the 22d, and there were no general cold wave warnings at all during the month. Seven lows moved across the country with a central pressure of 29.4 inches or lower at the maximum stage of their development and in three of these storms the pressure fell below 29 inches.

During 11 of the first 15 days of the month storm warnings were displayed either on the Great Lakes or the middle or north Atlantic coast. At 3 p. m. of the 1st a disturbance was central over eastern Pennsylvania, moving northeastward and increasing greatly in intensity, and storm warnings were ordered displayed on the New England coast. These warnings were fully verified.

On the morning of the 4th a disturbance, central over Illinois and moving northeastward, was expected to increase considerably in intensity as it advanced over the Lake region, and warnings were displayed at 10 a. m. on the Great Lakes, except on western Lake Superior and the western shore of Lake Michigan. At 8 p. m. the storm was central over Lake Huron with increasing intensity and storm warnings were ordered displayed on the Maine coast. During the night pressure fell decidedly over the northeastern States and a secondary disturbance developed over southern New York. At 9:30 a. m. of the 5th warnings were displayed from Delaware Breakwater northward to Portsmouth, N. H. The warnings on the Atlantic coast were fully verified and those on the Great Lakes were partially verified.

The next storm warnings were ordered at 2 p. m. of the 8th for the Atlantic coast at and between Cape Hatteras and Delaware Breakwater, as a disturbance then central off the southern North Carolina coast was expected to increase in intensity as it moved northeastward. At 9:30 p. m. the warnings were extended northward to Provincetown, Mass., and the following morning to Eastport, Me. These warnings were fully verified, the highest wind velocity reported being 64 miles an hour from the northeast at Cape Henry, Va.

At 8 p. m. of the 12th a disturbance of marked intensity was central over the middle Missouri Valley, moving northeastward and storm warnings were ordered displayed at 10 p. m. on Lake Superior, northern Lake Huron, and on Lake Michigan, except the extreme southern portion. By the following morning this disturbance had split and had two centers, one over eastern Minnesota and the other over Missouri. The latter became the main storm and increased greatly in intensity and during the afternoon and evening of the 13th the warnings were extended to cover all of the Great Lakes. In addition warnings were ordered displayed on the Atlantic coast

from Charleston, S. C., to Eastport, Me., at 10 p. m. This storm increased remarkably in extent and intensity and by the morning of the 14th its central pressure had fallen to 28.60 inches over upper Michigan and gales prevailed generally in middle and northern sections east of the Mississippi River. The winds were controlled by this storm to a great height and a naval balloon which left Rockaway, N. Y., at 12:15 p. m. on the 13th drifted rapidly northward and then north-northwestward to the southern end of James Bay, where it landed at 2 p. m. on the 14th. The center of this storm moved very little during the 14th and 15th and warnings remained displayed on the Great Lakes until the evening of the 15th, when the display of storm warnings for the season terminated. The highest velocities reported were 76 miles an hour from the southwest at Toledo, Ohio, and 72 miles an hour from the south at New York, N. Y. Little damage to shipping was reported as all possible precaution had been taken, due to the timely warnings issued.

On the evening of the 22d a storm of marked intensity was central over Michigan, moving east-northeastward, and storm warnings were ordered for the Atlantic coast from Cape Hatteras to Eastport, Me. On the 23d a velocity of 60 miles an hour from the west was registered at New York, N. Y., which was the only wind of gale force reported on the Atlantic coast. At Buffalo, N. Y., the wind reached a velocity of 96 miles an hour from the southwest, which is the highest ever recorded at that station.

At 10 p. m. of the 26th warnings were ordered displayed on the Atlantic coast from Delaware Breakwater to Eastport, Me., in connection with a disturbance which extended from Michigan southward to the Louisiana coast and with rapidly falling barometer to the eastward. On the 27th warnings were extended southward to Cape Hatteras. Although the pressure continued to fall rapidly no winds of gale force were reported at land stations until the storm center reached the Canadian Maritime Provinces, where gales and heavy snow were general.

Small-craft warnings were displayed on the east Gulf coast from Bay St. Louis, Miss., to Apalachicola, Fla., on the 21st and 26th and were fully justified.

Cold-wave warnings were not required for any part of the Washington district until the 27th, except for Mississippi, western Tennessee, extreme northwestern Florida, and along the Alabama coast on the 22d. On the 27th an extensive area of low pressure was moving rapidly eastward over the region of the Great Lakes and the Eastern States and it was followed by an area of high pressure and abnormally cold weather which had moved from Alberta southeastward to the Plains States. Cold-wave warnings were issued for the Ohio Valley, including all of Ohio, Tennessee, and the East Gulf States, and they were fully verified over most of this area. By the time the cold wave had reached eastern Ohio on the morning of the 28th, the crest of the high-pressure area had advanced to the west Gulf coast and pressure had fallen

to such an extent over the Plains States and the Northwest that warnings were ordered only for extreme northern Florida and the coast regions of Georgia and South Carolina.

Frost warnings were issued for portions of the East Gulf and south Atlantic States on numerous dates and were, in the main, well verified.—*Charles L. Mitchell.*

WARNINGS FROM OTHER DISTRICTS.

Chicago Forecast District.—With the exception of stock warnings on the morning of December 11 for Montana and Wyoming, no special advices of any kind were issued from the Chicago forecast center until the third decade of December, the winter up to that time being unusually mild and open. However, on the morning of December 20, a cold, high pressure area appeared in the Canadian Northwest preceded by a low of marked energy and cold wave warnings were ordered for the southern and central Plains States and the upper and lower Missouri Valley. These warnings were extended during the 21st and 22d to the eastern limits of the district. In connection with this disturbance, the stock interests in Wyoming, South Dakota, Nebraska, and Kansas were fully advised as to impending conditions, as well as heavy snow warnings issued for southern and central Wisconsin, eastern Iowa, and extreme northern Illinois. No warnings of any kind were necessary during the balance of the month.

During the period from December 10 to 20, inclusive, special forecast service was rendered the Liberal Auto & Supply Co., Liberal, Kans., each evening forecasts being telegraphed containing the expected weather for the next two days, as well as the probable minimum temperature for the following morning. This service was desired in connection with the work of erecting a large concrete and steel building. That the forecasts were much appreciated is shown by a copy of the following letter, which was received from the concern in question under date of December 21.

We wired you to-day: "Discontinue our weather service. Thanks." We have completed our roof on the garage building and your service has been very helpful. Your forecast has been accurate, there being scarcely a degree difference. Such service as yours makes one glad to know that he lives at this time of convenience and excellent service.

—*E. H. Haines.*

New Orleans Forecast District.—There were several windy days during the month, but no severe storms occurred. Small-craft warnings were displayed for all or part of the West Gulf coast on the 3d, 13th, 15th, 20th, 25th, and 26th, and were justified. The p. m. map of the 20th showed a well-defined disturbance over the upper Rio Grande Valley and southeast storm warnings were displayed from New Orleans to Corpus Christi, and were justified.

On the 6th a disturbance was central over Texas and an area of high pressure extended from the upper Missouri Valley southwestward across the Rocky Mountain States. Cold-wave warnings were ordered for the northwestern portion of the district, but the fall in temperature, as the depression moved eastward, was not sufficient for a cold wave. This was due partly to the fact that the temperatures within the anticyclone were not very low to begin with and partly to a tendency of the anticyclone to move eastward as well as southward, so that the main body of the anticyclonic area remained north of the cyclonic area.

Cold-wave warnings for the northern and western portions of the district were issued on indications of the

p. m. map of the 20th, when a depression was over New Mexico and an area of high pressure was central to the northward of eastern Montana, with conditions well defined. The warnings were verified in most localities, the temperature fall in Arkansas requiring more time than in other sections for which the warnings were issued.

On the 26th a trough of low pressure was over the Mississippi Valley and the West Gulf States and the pressure was high over western Canada. Cold-wave warnings were issued for Arkansas, eastern Oklahoma, and northern Texas, and were extended at night over northern Louisiana and to the central portion of east Texas. These warnings were generally verified. As in the preceding instance, the temperature fall in eastern and southern Arkansas, though large, was gradual. On the morning of the 28th, the cold wave reached also the lower Rio Grande Valley and the adjacent coast of Texas, with a temperature of 32° at Corpus Christi, the cold wave coming more directly south and causing a greater change on the coast than was expected.

Warnings for live-stock interests were sent out on the 6th, 21st, 26th, and 27th.

Warnings of frost or freezing temperature for coast and adjacent sections were issued on the 1st, 7th, 8th, 15th, 17th, 22d, 23d, 24th, 27th, and 28th, and were mostly verified.

Fire-weather warnings were telegraphed to Oklahoma and Arkansas on the 29th and conditions occurred as forecast.—*R. A. Dyke.*

Denver Forecast District.—On the 12th a low pressure center was over southeast Colorado. It moved north-eastward and on the morning of the 13th a moderate cold wave occurred without warnings in northwest New Mexico and adjacent parts of Arizona and Colorado. This was unusual as the low pressure center was located north of the area subsequently covered by the cold wave.

On the morning of the 20th an area of low barometer of considerable intensity occupied southern Utah. During the following 24 hours the disturbance was divided by a wedge of high pressure advancing southward along the eastern slope, one center moving to eastern Kansas while the other remained in northwestern New Mexico. Live-stock warnings were issued for eastern Colorado on the morning of the 21st. A sharp fall in temperature occurred in eastern Colorado, with zero temperatures, and strong winds in some localities.—*Frederick W. Brist.*

San Francisco Forecast District.—Frost warnings were issued in northern California on December 2, 4, and 7; in southern California and the San Joaquin Valley on December 12, and throughout the interior of California on December 13 and 20. The frosts were heavy but no material damage resulted.

Storm warnings were ordered as follows: December 1, at Point Reyes and advisory at all Washington and Oregon stations; 3d, at all Washington and Oregon stations; 5th, from Tatoosh to Mendocino; 6th, from Tatoosh to San Francisco; 7th, all Washington and Oregon stations; 9th, from Tatoosh to San Francisco; 10–11th, from Tatoosh to Point Reyes; 12th, 14th, 16th, all Washington and Oregon stations; 17th, from Tatoosh to Point Reyes; 19th, from San Francisco to San Diego; 23d, from Tatoosh to San Francisco; 26th, all Washington and Oregon stations; 27th, advisory followed by southwest warnings all Washington and Oregon stations; 29th, all Washington and Oregon stations; 30th, from Tatoosh to Point Reyes; 31st, all Washington and Oregon stations.

—*G. H. Willson.*